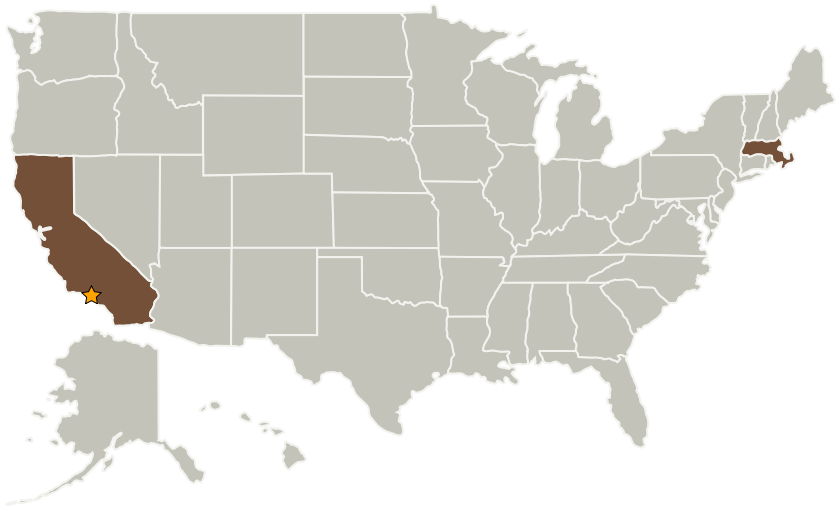
Topology Control Algorithms for Spacecraft Formation Flying Networks Under Connectivity and Time-Delay Constraints, Phase II

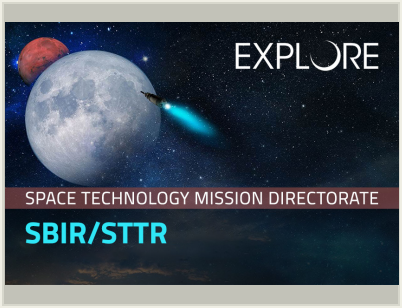
Completed Technology Project (2009 - 2011)

Project Introduction

SSCI is proposing to develop, test and deliver a set of topology control algorithms and software for a formation flying spacecraft that can be used to design and evaluate candidate formation architectures. Properties of these topology control algorithms include: (a) Preserving the connectivity of the underlying state-dependent sensing graph during reconfiguration and re-targeting of the formation; (b) Achieving a balanced interplay between performance and robustness to communication delays; and (c) Using only local information to make local decisions that collectively guarantee global properties such as the network connectivity for formation flying. Phase I effort resulted in the development of a unified framework for the design and analysis of many topology control problems associated with formation flying spacecraft. A novel game-theoretic approach to network topology control was successfully applied to key trajectory design problems such as formation initialization and reconfiguration in the presence of local and global constraints. Phase II effort will deliver a complete set of algorithms and software tools to help the NASA TPF-I team plan and evaluate missions for candidate TPF-I architectures. In order to achieve these objectives, we plan to carry out the following tasks: (i) Further refinements and testing of the game-theoretic approach to state-dependent network synthesis problems and trajectory-following in the absence of centralization, (ii) Development and testing of convex parameterization of path-planning problems for multiple spacecraft formations, (iii) Demonstration of the application of the developed novel methods to TPF-I baseline mission. These algorithms and software will be tested on high fidelity formation flying testbeds at JPL such as FAST or FCT. Professor Mehran Mesabhi of University of Washington will provide technical support under the project.

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Scientific Systems Company, Inc.	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Woburn, Massachusetts

Primary U.S. Work Locations	
California	Massachusetts

Project Transitions

December 2009: Project Start

December 2011: Closed out

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.3 Control Technologies
    - TX17.3.1 Onboard Maneuvering / Pointing / Stabilization / Flight Control Algorithms